

# AN11697

## PN7120 Linux Software Stack Integration Guidelines

Rev. 1.1 — 24 August 2015  
335011

Application note  
COMPANY PUBLIC

### Document information

Info	Content
<b>Keywords</b>	NFC, Linux, Libnfc-nci
<b>Abstract</b>	This note describes how to add support for a PN7120 NFC Controller to a generic GNU/Linux system



**Revision history**

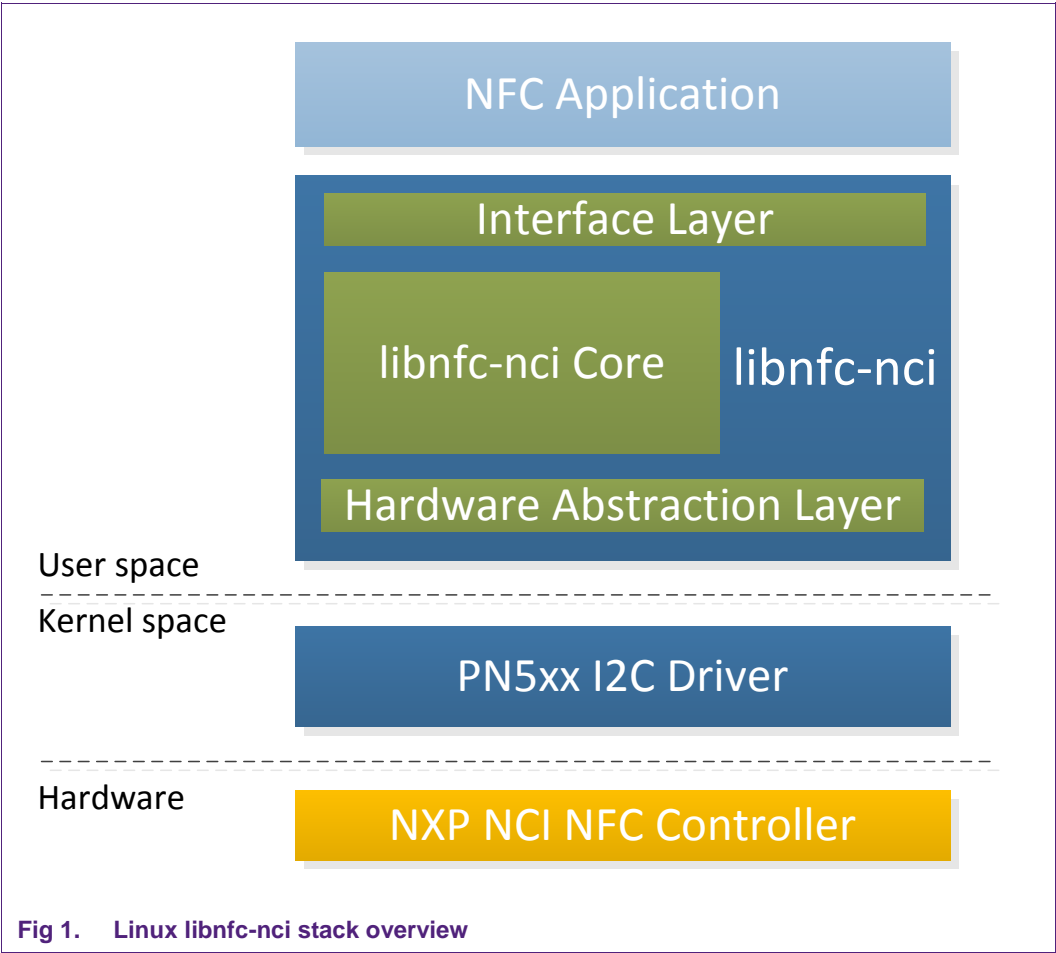
Rev	Date	Description
1.1	20150824	Updated to R1.0 software stack version
1.0	20150601	First released version
0.1	20150507	Creation of the document

**Contact information**

For more information, please visit: <http://www.nxp.com>

1. Introduction

This document provides guidelines for the integration of NXP’s PN7120 NFC Controller to a generic GNU/Linux platform from software perspective, based on the Linux NFC stack. The related architecture is depicted in below Fig 1.



## 2. Release note

---

The present document describes the Linux libnfc-nci stack version R1.0.

### 2.1 Change history

#### 2.1.1 R1.0

- 
- Fixed SNEP Connect Error on PC x64 platform
- Fixed issue of failing initialization due to DWL\_GPIO not connected or not defined
- Fixed error during receive of BT CHO message
- Fixed error during receive of WIFI CHO message
- Fixed issue of Handover select API returning success for corrupted payload
- Fixed issue of HCE data receive call back not being invoked in case of receiving check NDEF frame
- Fixed error during multiprotocol card reading
- Fixed status error when push message failed
- Fixed segmentation fault in case of URI NDEF record with invalid/RFU prefixes
- Fixed MIFARE Classic buffer de-allocation during write
- Fixed RF Stuck issue during P2P or tag write

#### 2.1.2 R0.4

First official delivery of the Linux libnfc-nci stack.

### 2.2 Possible problems, known errors and restrictions

None

## 3. Kernel driver

The Linux libnfc-nci stack uses PN5xx I2C kernel mode driver to communicate with the NXP NCI NFC Controller. It is available from the following repository:  
<http://www.github.com/NXPnFCLinux/nxp-pn5xx>.

### 3.1 Driver details

The PN5xx I2C driver offers communication to the NFC Controller connected over I2C physical interface. This is insured through the device node named `/dev/pn544`. This driver is compatible with a large range of NXP's NFC Controllers (e.g. PN544).

### 3.2 Installation instructions

The following instructions assume the driver being installed under the `drivers/misc` kernel source sub-folder. Below instructions may have to be adapted accordingly in case another path is chosen for the driver installation.

#### 3.2.1 Getting the driver

Clone the nxp-pn5xx repository into the kernel directory:

```
$ cd drivers/misc
$ git clone https://github.com/NXPnFCLinux/nxp-pn5xx.git
```

This will create the sub-folder `nxp-pn5xx` containing the following files:

- `pn5xx_i2c.c`: driver implementation
- `pn5xx_i2c.h`: driver interface definition
- `README.md`: repository comments
- `Makefile`: driver related makefile
- `Kconfig`: driver related config file
- `LICENSE`: driver licensing terms
- `sample_devicetree.txt`: example of device tree definition

#### 3.2.2 Including the driver to the kernel

Include the driver to the compilation by adding below line to the heading makefile (`drivers/misc/Makefile`).

```
obj-y += nxp-pn5xx/
```

Include the driver config by adding below line to the heading configuration file (`drivers/misc/Kconfig`).

```
source "drivers/misc/nxp-pn5xx/Kconfig"
```

### 3.2.3 Creating the device node

Two methods are supported for the creation of the `/dev/pn544` device node: device tree and platform data. Any of the two methods can be used, but of course the I2C address (0x28 in the below examples) and GPIO assignments must be adapted to the hardware integration in the platform.

#### 3.2.3.1 Device tree

Below is an example of definition to be added to the platform device tree file (`.dts` file located for instance under `arch/arm/boot/dts` kernel sub-folder for ARM based platform).

```
&i2c{
    status = "okay";
    pn547: pn547@28 {
        compatible = "nxp,pn547";
        reg = <0x28>;
        clock-frequency = <400000>;
        interrupt-gpios = <&gpio2 17 0>;
        enable-gpios = <&gpio4 21 0>;
    };
};
```

#### 3.2.3.2 Platform data

Below is an example of definition to be added to the platform definition file. The structure `pn544_i2c_platform_data` being defined in the driver interface header file, `pn5xx_i2c.h` must be included in the platform definition file, and `pn5xx_i2c.h` file must be copied to `include/linux` kernel source sub-folder.

```
static struct pn544_i2c_platform_data nfc_pdata = {
    .irq_gpio = GPIO_TO_PIN(1,29),
    .ven_gpio = GPIO_TO_PIN(0,30),
    .firm_gpio = GPIO_UNUSED
    .clkreq_gpio = GPIO_UNUSED
};

static struct i2c_board_info __initdata nfc_board_info[] = {
    {
        I2C_BOARD_INFO("pn547", 0x28),
        .platform_data = &nfc_pdata,
    },
};
```

Then the declared **`nfc_board_info`** structure must be added to the platform using dedicated procedure (platform specific).

### 3.2.4 Building the driver

Through *menuconfig* procedure include the driver to the build, as built-in (<\*>) or modularizes features (<M>):

```
Device Drivers --->
  Misc devices --->
    < > NXP PN5XX based driver
```

If <M> option is selected, build the driver and install the generated *pn5xx\_i2c.ko* module. Otherwise if built-in, build the complete kernel, the driver will be included in the kernel.

If the device tree method was used in previous step, build the platform related device tree and install generated .dtb file.

### 3.2.5 Changing access to device node

By default, r/w permission to the */dev/pn544* node is set to root user only. This might be an issue when running an application without root privilege.

Permissions of the device node can be changed on the platform, by instance using *udev* rules management. For example, creating a new file named *pn5xx\_i2c.rules* located in */etc/udev/rules.d* platform sub-directory, and containing such line declaration:

```
ACTION=="add", KERNEL=="pn544", MODE="0666"
```

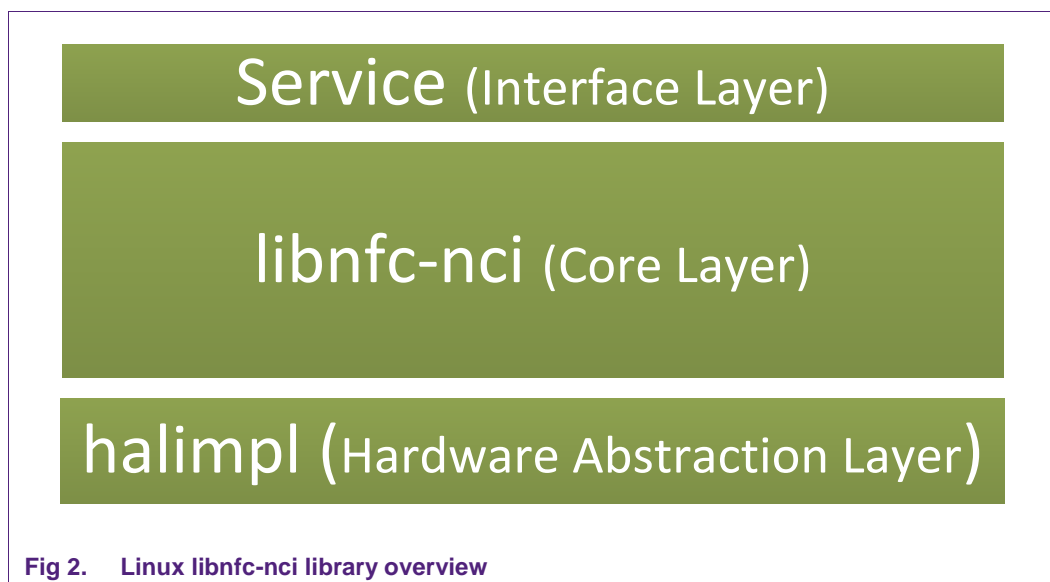
This will update the device node permission, to r+w to any user, during platform boot.

## 4. NFC library

The Linux libnfc-nci stack consists in a library running in User space. It is available from the following repository: [http://www.github.com/NXPnFCLinux/linux\\_libnfc-nci](http://www.github.com/NXPnFCLinux/linux_libnfc-nci).

### 4.1 Library details

The library is comprised of 3 layers:



- The Interface layer expose the library API
- The Core layer implement NFC features (NCI, NDEF, LLCP and SNEP protocols, Tag Operations, Host Card Emulation...)
- The Hardware Abstraction Layer provides connection to the kernel driver as well as basic functionalities like self-test or firmware update

### 4.2 Installation instructions

#### 4.2.1 Getting the library

Clone the Linux libnfc-nci stack repository:

```
$ git clone https://github.com/NXPnFCLinux/linux_libnfc-nci.git
```



The following directory structure will be created:

```
|— conf
|   |— PN7120
|   |   |— libnfc-brcm.conf
|   |   |— libnfc-nxp.conf
|   |
|— demoapp
|   |— ...
|
|— doc
|   |— Linux_NFC_API_Guide
|   |   |— ...
|   |— Linux_NFC_API_Guide.html
|   |— AN11697 - PN7120 Linux Software Stack Integration Guidelines.pdf
|
|— src
|   |— halimpl
|   |   |— ...
|   |— include
|   |   |— ...
|   |— libnfc-nci
|   |   |— ...
|   |— service
|   |   |— ...
|
|— bootstrap
|— configure.ac
|— Makefile.am
```

#### 4.2.1 Generating the configuration script

Generate the configuration script by simply executing the bootstrap bash script:

```
$ ./bootstrap
```

This requires the *automake*, *autoconf* and *libtool* packages to be installed on the machine used for compilation (directly on the target or cross-compiling machine). This can be done using standard *apt-get install* procedure.

#### 4.2.2 Generating the Makefile

Call the newly created configure script enabling the generation of the Makefile recipe file:

```
$ ./configure <OPTIONS>
```

Here are some options one might be interested in when cross-compiling:

- `--host=HOST`: cross-compile to build programs to run on HOST.
- `--prefix=PREFIX`: install files in PREFIX. PREFIX is generally the path to either the target's or cross-compilation toolchain's `/usr/directory`.
- `--sysconfdir=DIR`: install configuration files in DIR.
- `-h`: display all available command-line options.

#### 4.2.3 Building the source

Using the *Makefile* recipe file, building the library and the test application is done with the simple make command:

```
$ make
```

#### 4.2.4 Installing the library

The generated library can be installed on the target using *make install* command.

Depending on the target directories, installation may require the use of root privileges, generally granted by *su* or *sudo*:

```
# make install
```

This will install the `libnfc-nci-linux` library to `/usr/local/lib` target directory (this path must be added to `LD_LIBRARY_PATH` environment variable for proper reference to the library during linking/execution of application).

This will also install the configuration files (refer to chapter 4.4) to the directory defined according to `--prefix`.

The `libnfc-nci` library expects to find the conf files in the `/etc` target directory. Pay attention to set properly the path of installation during makefile generation procedure (refer to chapter 4.2.2). For instance if the library is built on the target, configure script must have been run with option `--sysconfdir=/etc`.

### 4.3 Library APIs

For detailed information about `libnfc-nci` library API, please refer to the dedicated document *Linux\_NFC\_API\_Guide.html* inside *doc* sub-folder of the stack delivery (refer to chapter 4.2.1).

## 4.4 Configuration Files

Two files allow configuring the libnfc-nci library at runtime: *libnfc-brcm.conf* and *libnfc-nxp.conf*. There are defining tags which are impacting library behavior. The value of the tags depends on the NFC Controller IC and the targeted platform. For more details, refer to the examples given in *conf* sub-folder of the stack delivery (see chapter 4.2.1).

These files are loaded by the library, from */etc* directory of the target, during the initialization phase. Refer to chapter 4.2.4 for installation procedure, the files can also be manually copied to the target */etc* directory.

## 5. Example application

### 5.1 Application details

The Linux libnfc-nci stack offers an application example demonstrating use of the library to run NFC features. It is available as part of the stack delivery (refer to chapter 4.2 for installation instructions). Source code is located in *demoapp* sub-folder of the libnfc-nci stack directory.

The purpose of this application is to demonstrate NFC features offers by the libnfc-nci library and provides code example of the library API.

It is built together the libnfc-nci library, following procedure depicted in chapter 4.2.3.

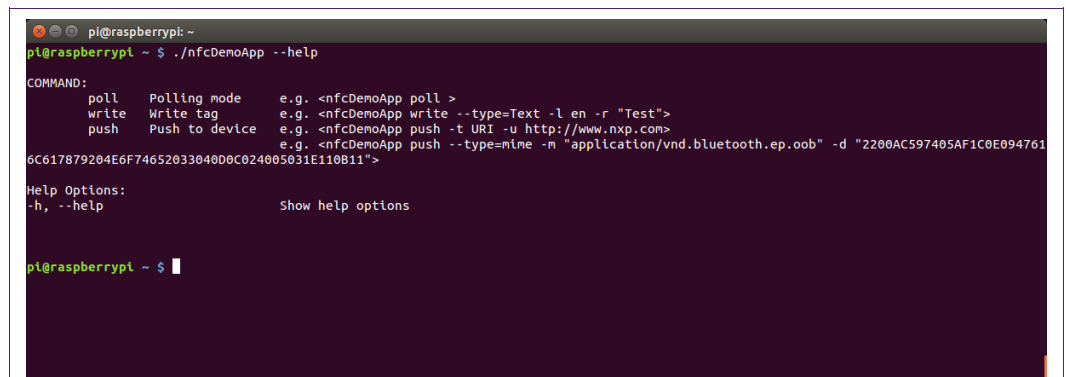
### 5.2 Using the application

The application must be started with parameters:

```
$ ./nfcDemoApp <OPTIONS>
```

You can get the parameters details by launching the application help menu:

```
$ ./nfcDemoApp write --help
```



```
pi@raspberrypi: ~$ ./nfcDemoApp --help
COMMAND:
  poll      Polling mode      e.g. <nfcDemoApp poll >
  write     Write tag         e.g. <nfcDemoApp write --type=Text -l en -r "Test">
  push     Push to device     e.g. <nfcDemoApp push -t URI -u http://www.nxp.com>
                                   e.g. <nfcDemoApp push --type=mime -m "application/vnd.bluetooth.ep.oob" -d "2200AC597405AF1C0E094761
6C617879204E6F74652033040D0C024005031E110B11">

Help Options:
-h, --help          Show help options

pi@raspberrypi ~$
```

Fig 3. Linux demo application commands

The demo application offers 3 modes of operation:

- **Polling:** continuously waiting for a remote NFC device (tag or peer device) and displays related information
- **Tag writing:** allows writing NDEF content to a NFC tag
- **Device push:** allows pushing NDEF content to a remote NFC peer device

### 5.2.1 Polling mode

When in this mode, the application will display information of any discovered NFC tags or remote NFC device. It is reached starting the application with “poll” parameter:

```
$ ./nfcDemoApp poll
```

```

pi@raspberrypi: ~
pi@raspberrypi ~$ ./nfcDemoApp poll
##### NFC demo #####
##### Poll mode activated #####
##### ... press enter to quit ... #####

Waiting for a Tag/Device...

NFC Tag Found

Type : 'Type A - Mifare UL'
Record Found :
NDEF Content Max size : '868 bytes'
NDEF Actual Content size : '29 bytes'
ReadOnly : 'FALSE'
Type : 'URI'
URI : 'http://www.nxp.com/demoboard/OM5577'

29 bytes of NDEF data received :
D1
01 19 55 01 6E 78 70 2E 63 6F 6D 2F 64 65 6D 6F 62 6F 61 72 64 2F 4F 4D 35 35 37 37
NFC Tag Lost

Waiting for a Tag/Device...

```

Fig 4. Linux demo application polling mode

### 5.2.2 Tag writing mode

This mode allows writing data to an NFC tag. It is reached using “write” parameter:

```
$ ./nfcDemoApp write <OPTIONS>
```

```

pi@raspberrypi: ~
pi@raspberrypi ~$ ./nfcDemoApp write --type=Text -l en -r "Hello World"
##### NFC demo #####
##### Write mode activated #####
##### ... press enter to quit ... #####

Waiting for a Tag/Device...

NFC Tag Found

Type : 'Type A - Mifare UL'
Record Found :
NDEF Content Max size : '137 bytes'
NDEF Actual Content size : '29 bytes'
ReadOnly : 'FALSE'
Type : 'URI'
URI : 'http://www.nxp.com/demoboard/om5577'

29 bytes of NDEF data received :
D1
01 19 55 01 6E 78 70 2E 63 6F 6D 2F 64 65 6D 6F 62 6F 61 72 64 2F 6F 6D 35 35 37 37
Write Tag OK
Read back data
Record Found :
NDEF Content Max size : '137 bytes'
NDEF Actual Content size : '18 bytes'
ReadOnly : 'FALSE'
Type : 'Text'
Text : 'hello world'

18 bytes of NDEF data received :
D1
01 0E 54 02 65 6E 68 65 6C 6C 6F 20 77 6F 72 6C 64
NFC Tag Lost

Waiting for a Tag/Device...

```

Fig 5. Linux demo application tag writing mode

You can get more information about the message format using “-h” or “--help” parameter:

```
$ ./nfcDemoApp write --help
```

### 5.2.3 Device push mode

This mode allows pushing data to a remote NFC device (e.g. an NFC phone). It is reached using “push” parameter:

```
$ ./nfcDemoApp push <OPTIONS>
```

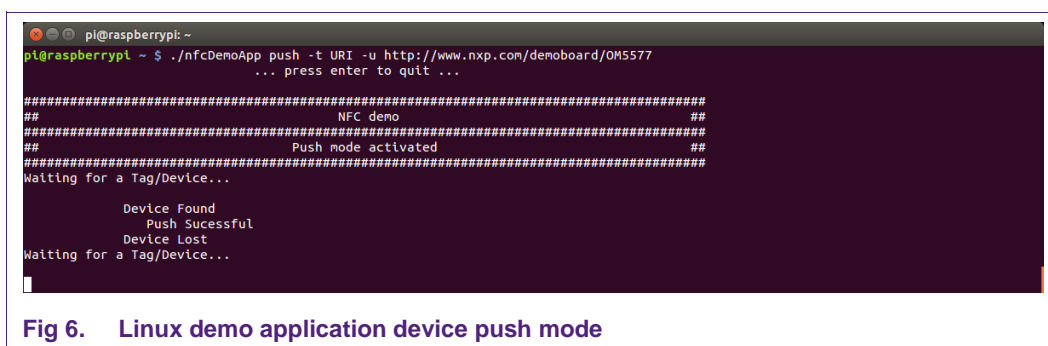


Fig 6. Linux demo application device push mode

You can get more information about the message format using “-h” or “--help” parameter:

```
$ ./nfcDemoApp push --help
```

## 6. Legal information

### 6.1 Definitions

**Draft** — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

### 6.2 Disclaimers

**Limited warranty and liability** — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

**Right to make changes** — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

**Suitability for use** — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

**Applications** — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

**Export control** — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

**Translations** — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

**Evaluation products** — This product is provided on an "as is" and "with all faults" basis for evaluation purposes only. NXP Semiconductors, its affiliates and their suppliers expressly disclaim all warranties, whether express, implied or statutory, including but not limited to the implied warranties of non-infringement, merchantability and fitness for a particular purpose. The entire risk as to the quality, or arising out of the use or performance, of this product remains with customer.

In no event shall NXP Semiconductors, its affiliates or their suppliers be liable to customer for any special, indirect, consequential, punitive or incidental damages (including without limitation damages for loss of business, business interruption, loss of use, loss of data or information, and the like) arising out of the use of or inability to use the product, whether or not based on tort (including negligence), strict liability, breach of contract, breach of warranty or any other theory, even if advised of the possibility of such damages.

Notwithstanding any damages that customer might incur for any reason whatsoever (including without limitation, all damages referenced above and all direct or general damages), the entire liability of NXP Semiconductors, its affiliates and their suppliers and customer's exclusive remedy for all of the foregoing shall be limited to actual damages incurred by customer based on reasonable reliance up to the greater of the amount actually paid by customer for the product or five dollars (US\$5.00). The foregoing limitations, exclusions and disclaimers shall apply to the maximum extent permitted by applicable law, even if any remedy fails of its essential purpose.

### 6.3 Licenses

#### Purchase of NXP ICs with NFC technology

Purchase of an NXP Semiconductors IC that complies with one of the Near Field Communication (NFC) standards ISO/IEC 14443 and ISO/IEC 21481 does not convey an implied license under any patent right infringed by implementation of any of those standards.

### 6.4 Trademarks

Notice: All referenced brands, product names, service names and trademarks are property of their respective owners.

**MIFARE** — is a trademark of NXP Semiconductors N.V.

7. List of figures

Fig 1. Linux libnfc-nci stack overview .....3

Fig 2. Linux libnfc-nci library overview .....8

Fig 3. Linux demo application commands ..... 12

Fig 4. Linux demo application polling mode ..... 13

Fig 5. Linux demo application tag writing mode ..... 13

Fig 6. Linux demo application device push mode ..... 14



## 8. Contents

---

<b>1.</b>	<b>Introduction .....</b>	<b>3</b>	<b>7.</b>	<b>List of figures.....</b>	<b>16</b>
<b>2.</b>	<b>Release note .....</b>	<b>4</b>	<b>8.</b>	<b>Contents .....</b>	<b>17</b>
2.1	Change history .....	4			
2.2	Possible problems, known errors and restrictions.....	4			
<b>3.</b>	<b>Kernel driver .....</b>	<b>5</b>			
3.1	Driver details .....	5			
3.2	Installation instructions .....	5			
3.2.1	Getting the driver.....	5			
3.2.2	Including the driver to the kernel .....	5			
3.2.3	Creating the device node .....	6			
3.2.3.1	Device tree .....	6			
3.2.3.2	Platform data.....	6			
3.2.4	Building the driver .....	7			
3.2.5	Changing access to device node .....	7			
<b>4.</b>	<b>NFC library .....</b>	<b>8</b>			
4.1	Library details .....	8			
4.2	Installation instructions .....	8			
4.2.1	Getting the library.....	8			
4.2.1	Generating the configuration script .....	9			
4.2.2	Generating the Makefile .....	9			
4.2.3	Building the source.....	10			
4.2.4	Installing the library .....	10			
4.3	Library APIs.....	10			
4.4	Configuration Files .....	11			
<b>5.</b>	<b>Example application.....</b>	<b>12</b>			
5.1	Application details .....	12			
5.2	Using the application.....	12			
5.2.1	Polling mode .....	13			
5.2.2	Tag writing mode.....	13			
5.2.3	Device push mode .....	14			
<b>6.</b>	<b>Legal information .....</b>	<b>15</b>			
6.1	Definitions .....	15			
6.2	Disclaimers.....	15			
6.3	Licenses.....	15			
6.4	Trademarks.....	15			

---

Please be aware that important notices concerning this document and the product(s) described herein, have been included in the section 'Legal information'.

---